



# Prehospital Predictors of Initial Shockable Rhythm in Out-of-Hospital Cardiac Arrest: Findings From the Taichung Sudden Unexpected Death Registry (THUNDER)

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## Abstract

**Objective:** To identify the incidence and prehospital predictors of ventricular tachycardia/ventricular fibrillation (VT/VF) as the initial arrhythmia in patients with out-of-hospital cardiac arrest (OHCA) in central Taiwan.

**Patients and Methods:** The Taichung Sudden Unexpected Death Registry program encompasses the Taichung metropolitan area in central Taiwan, with a population of 2.7 million and 17 destination hospitals for patients with OHCA. We performed a detailed analysis of demographic characteristics, circumstances of cardiac arrest, and emergency medical service records using the Utstein Style.

**Results:** From May 1, 2013, through April 30, 2014, resuscitation was attempted in 2013 individuals with OHCA, of which 384 were excluded due to trauma and noncardiac etiologies. Of the 1629 patients with presumed cardiogenic OHCA, 7.9% (n=129) had initial shockable rhythm; this proportion increased to 18.8% (61 of 325) in the witnessed arrest subgroup. Male sex (odds ratio [OR], 2.45; 95% CI, 1.46-4.12;  $P<.001$ ), age younger than 65 years (OR, 2.39, 95% CI, 1.58-3.62;  $P<.001$ ), public location of arrest (OR, 4.61; 95% CI, 2.86-7.44;  $P<.001$ ), and witnessed status (OR, 3.98; 95% CI, 2.62-6.05;  $P<.001$ ) were independent predictors of VT/VF rhythm.

**Conclusion:** The proportion of patients with OHCA presenting with VT/VF was generally low in this East Asian population. Of the prehospital factors associated with VT/VF, public location of OHCA was the strongest predictor of VT/VF in this population, which may affect planning and deployment of emergency medical services in central Taiwan.

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Out-of-hospital sudden cardiac arrest (OHCA) is a leading health problem worldwide, accounting for 15% to 20% of all natural adult deaths and up to 50% of cardiovascular deaths.<sup>1</sup> Despite a decade of advances in research and treatment of OHCA, only 5% to 10% of patients survive to be discharged from the hospital.<sup>2-4</sup> However, individuals with OHCA who initially present with shockable ventricular tachycardia/ventricular fibrillation (VT/VF) rhythm have a substantially better survival rate (10%-

30%).<sup>5</sup> Prevention, early detection, and reversal of VT/VF are pivotal approaches to reducing mortality. Based on this concept, a variety of strategies have been proposed to improve survival in patients with OHCA, including identification of high-risk patients and implantation of intracardiac defibrillators,<sup>6</sup> increased use of bystander cardiopulmonary resuscitation (CPR), and public deployment of the automated external defibrillator (AED).<sup>4</sup>

Rates of VT/VF and survival from OHCA seem to vary from continent to continent.



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Asians have the lowest rates of VT/VF and survival to hospital discharge compared with Americans, Europeans, and Australians.<sup>5</sup> However, in individuals with OHCA with initial presentation of VT/VF, Asians have a comparable survival to discharge rate.<sup>5</sup> Overall, the incidence of VT/VF is approximately 20% to 30% in white patients with OHCA<sup>7-9</sup> but only 5% to 10% in East Asian populations.<sup>5,10,11</sup> In bystander-witnessed nontrauma OHCA populations, the difference in VT/VF incidence between Western (60%-80%) and Asian (20%) people was even greater.<sup>12-14</sup> Whether this discrepancy is related to the delay in the response time (time from the call for help to ambulance arrival at the scene) or other factors remains incompletely studied. Furthermore, information about the risk factors or predictors of VT/VF in East Asian patients with OHCA is limited. Therefore, it is important to explore the hallmarks of VT/VF as the first presenting arrhythmia in patients with OHCA to improve survival and quality of life in patients with sudden cardiac death in this region.

Leveraging findings from the Taichung Sudden Unexpected Death Registry (THUNDER) encompassing a population of 2.7 million in central Taiwan, we sought to determine the incidence, risks, and outcomes of patients with OHCA with VT/VF as the first presenting arrhythmia in relation to detailed prehospital information. The goal was to advance knowledge about the regional epidemiology of OHCA and pave the way for implementing evidence-based management of OHCA in this region.

## METHODS

### Study Design and Setting

The THUNDER program, which started May 1, 2013, encompasses Taichung and 17 destination hospitals for patients with OHCA. Taichung, located in central Taiwan, encompasses 2215 km<sup>2</sup> of mixed urban, suburban, and rural areas. In 2014, the total population of Taichung was 2,711,252 residents, and the population density was 1605 persons per square kilometer.<sup>15</sup> This registry, which includes demographic information, emergency medical service (EMS) records, and hospital data, was constructed using the EMS run sheets of patients with OHCA transported by the 119 EMS ambulances according to the Utstein Style.<sup>16,17</sup> The research protocol

was approved by the institutional review board of China Medical University Hospital (Taichung, Taiwan) and was conducted in compliance with the relevant national ethical and regulatory guidelines.

Cardiac arrest was defined as the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation.<sup>16,17</sup> The arrest was presumed to be of cardiac origin unless it was caused by trauma, drowning, drug overdose, asphyxia, exsanguinations, or any other noncardiac causes. These diagnoses were clinically determined by the emergency department physician in charge in collaboration with the EMS rescuers.<sup>18</sup> For ambiguous cases, the diagnosis of presumed cardiac OHCA was adjudicated by the expert panel composed of experienced cardiologists and emergency department physicians.

### Data Collection

Data were prospectively collected using a universal form that included all core data recommended in the Utstein Style reporting guidelines for cardiac arrests.<sup>16,17</sup> These data included age, sex, witnessed status, first documented cardiac rhythm, location of arrest, time course of resuscitation, bystander-initiated CPR, AED use, return of spontaneous circulation (ROSC), survival, and neurologic status.

To verify the proportion of AED-read shockable or nonshockable rhythm, a subset of AED-stored electrocardiographic (ECG) recordings was retrieved using dedicated software (RescueLink version 10.15; Cardiac Science) and were analyzed by experienced cardiologists blinded to the AED-read rhythm. The agreement between AED-read shockable rhythm and cardiologist-adjudicated VT/VF rhythm was assessed using the Cohen kappa coefficient. A coefficient of 0.0 to 0.20 denotes slight agreement; 0.21 to 0.40, fair agreement; 0.41 to 0.60, moderate agreement; 0.61 to 0.80, substantial agreement, and 0.81 or greater, almost perfect agreement.

### Statistical Analyses

The demographic and prehospital characteristics of patients with OHCA were compared in patients stratified by response times using analysis of variance for continuous variables and the  $\chi^2$  test or the Fisher exact test for categorical variables. Response time was categorized into 3 groups (<6, 6-12, and >12 minutes) to assess

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